

## SCREW CAP TIGHTENER APPARATUS

The present invention relates to apparatus for tightening screw caps.

### 5 BACKGROUND OF THE INVENTION

Numerous types of screw cap tightener apparatus are known, in particular apparatus comprising a gripper head fixed to a rotary spindle connected to a drive shaft via a friction clutch whose adhesion limit corresponds to the  
10 tightening torque which it is desired to apply to the screw cap. Given the way that type of apparatus operates, the clutch is intended to slip each time a screw cap is tightened, and as a result the friction elements thereof are subjected to rapid wear, which means  
15 that the tightener apparatus needs to be stopped frequently in order to adjust the settings of the friction elements in order to obtain the desired torque. In addition, the clutch increases the inertia of the spindle, which means that small tightening torques are  
20 difficult to control with that kind of tightener apparatus.

Pneumatic apparatus is also known comprising an actuator whose rod carries a rack connected via drive take-off gearwheels to a rotary spindle carrying the  
25 gripper head. The clamping torque is determined by the pressure fed to the pneumatic actuator and it can be adjusted once and forever to a given clamping torque for the screw caps. Nevertheless, because of the drive take-off mechanism of the rack connected to the pneumatic  
30 actuator, that apparatus presents considerable size, thereby limiting the number of screw cap tightener apparatuses that can be installed on a single machine.

### OBJECT OF THE INVENTION

35 An object of the present invention is to provide screw cap tightener apparatus acting in simple and

reliable manner to limit tightening torque while being compact.

#### BRIEF SUMMARY OF THE INVENTION

5           In order to achieve this object, the invention provides a screw cap tightener apparatus comprising a turntable, a spindle mounted on the turntable to rotate relative thereto, a screw cap gripper head secured to the spindle, drive means to rotate the spindle by exerting an  
10 off-center drive force on the spindle, means engaging a portion of the spindle that is stationary in rotation to detect a force applied in reaction to the drive force, and means for stopping tightening, said means being connected to the detector means to stop tightening when  
15 the force applied in reaction exceeds a predetermined threshold.

          By applying an off-center force to the spindle, torque is generated thereon, giving rise to a force which is applied in reaction on a non-rotary portion of the  
20 spindle and which increases as the torque opposing tightening increases. The reaction force can thus be used to evaluate the tightening torque, and tightening can be caused to stop as a function of said reaction force, which reaction force is representative of the  
25 tightening torque. The detector means which detect this force via a non-rotary portion of the spindle has no influence on the inertia of the spindle and also makes it possible to obtain a structure that is simple and reliable (particularly in terms of the connections that  
30 need to be made thereto).

          In a first embodiment, the spindle is mounted on the turntable with lateral clearance to be movable between a tightening position and an end-of-tightening position, and the means for detecting the applied force comprises  
35 means for resiliently returning the spindle towards the tightening position, and means for detecting the position of the spindle, the means for stopping tightening being

connected to the position detector means in order to stop tightening when the spindle reaches the end-of-tightening position.

5       The structure of the apparatus is then relatively simple.

      In which case, the spindle is advantageously mounted on the turntable via a guide element mounted on the turntable with lateral clearance so as to be movable between the tightening position and the end-of-tightening position, and the resilient return means is interposed  
10       between the turntable and the guide element.

      Torque can thus be read and adjusted on a portion that is secured to the turntable.

      In this embodiment, the resilient return means  
15       preferably comprises an arm having one end hinged to the turntable and an opposite end close to which the position detector means is mounted, and a spring interposed between the turntable and the arm to maintain an intermediate portion of the arm bearing against the guide  
20       element.

      The arm serves to amplify the displacement of the guide element, which displacement is then more easily detected by the position detector means. It is then also possible to modify the tightening torque applied to the  
25       screw cap merely by modifying the force exerted by the spring.

      In which case, the tightener apparatus preferably includes a member for prestressing the spring, said member comprising a lever having a first end hinged on  
30       the second end of the arm, and a second end to which a first end of a rod passing through the arm is coupled, the rod having a second end provided with a shoulder, the spring being disposed around the rod between the arm and the shoulder at the second end of the rod, and the lever  
35       being in abutment against an eccentric secured to the turntable in such a manner that the spring presses the arm against the guide element, the eccentric being

mounted on the turntable so as to be capable of being pivoted to adjust the angle between the lever and the arm.

5 The force exerted by the spring is adjusted simply by adjusting the prestress thereon.

According to a particular characteristic of the first embodiment, the spindle is mounted to slide relative to the turntable during tightening, and the apparatus includes additional guide means arranged to  
10 provide accurate guidance in sliding over a fraction of tightening, and allowing movement corresponding to the lateral clearance at the end of tightening. Preferably, the additional guide means comprise two elements, one of which is secured to the spindle and the other to the  
15 turntable, i.e. an element comprising a column having a first segment and a second segment, the first segment being greater in diameter than the second segment, and an element comprising a ring having in inside diameter substantially equal to the diameter of the first segment  
20 and mounted to slide along the column.

This characteristic is particularly useful when the screw cap for tightening includes respective  
tamperproofing rings for co-operating with collars on the necks that are to receive the caps and retain the  
25 tamperproofing rings thereon. In order to force the ring over the collar during tightening, it is necessary in some circumstances to exert torque on the screw cap that is greater than the desired final tightening torque. The additional guide means prevent the spindle from moving  
30 when in the end-of-tightening position due to the tamperproofing ring passing over the collar at the beginning of tightening, thus preventing the spindle from being stopped too soon.

In a second embodiment, the detector means comprises  
35 means for detecting a bearing reaction of the spindle, and, preferably, the means for detecting the bearing reaction comprise a strain gauge.

The tightener apparatus of this embodiment is particularly advantageous since the information supplied by the strain gauge can be used to deliver the tightening torque continuously throughout tightening. The apparatus is also simple in structure, thereby limiting the number of moving parts and thus improving reliability.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Other characteristics and advantages of the invention appear further on reading the following description of a particular and non-limiting embodiment of the invention.

Reference is made to the accompanying figures, in which:

• Figure 1 is a diagrammatic section view of the top portion of tightener apparatus constituting a first embodiment of the invention;

• Figure 2 is a view analogous to Figure 1 showing the bottom portion of the apparatus;

• Figure 3 is a fragmentary section view on line III-III of Figure 2;

• Figure 4 is a section view on line IV-IV of Figure 3; and

• Figure 5 is a view analogous to the view of Figure 2 showing the bottom portion of tightener apparatus constituting a second embodiment of the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

With reference to Figures 1 to 4, the tightener apparatus constituting the first embodiment of the invention is described herein as applies to a carrousel-type capping installation comprising a plurality of tightener apparatuses grouped together on a platform given overall reference 1 and mounted to turn under drive from means that are not shown about a central column 2 of a stationary structure.

The platform 1 comprises superposed bottom and top turntables 3 and 4 held spaced apart by vertical columns 5, only one of which is visible in the figures.

Each tightener apparatus comprises a support  
5 assembly constituted in this case by facing portions of the turntables 3 and 4 and by the adjacent column 5.

A slider 6 is mounted free to move in rotation and in translation on the column 5. The slider 6 is fitted with a cam-follower wheel 7 mounted to rotate about an  
10 axis perpendicular to the column 5. The wheel 7 runs along an edge of a drum cam 8 secured to the central column 2 in order to determine the height of the slider 6 relative to the central column 2.

The tightener apparatus comprises a spindle given  
15 overall reference 9 and mounted on the support assembly defined in the platform 1, the spindle extending parallel to the column 5.

The spindle 9 comprises a sheath 10 which is secured to the slider 6 and which forms a portion of the spindle  
20 9 that does not rotate.

A shaft 11 is mounted to rotate inside the sheath 10 to form the rotary portion of the spindle 9. The shaft 11 possesses a top end 12 which projects from the sheath 10 and which is provided with a gearwheel 13 for meshing  
25 with a toothed wheel 14 secured to the central column 2, and a bottom end 15 projecting from the sheath 10 beneath the bottom turntable 3 and fitted with a gripper head given overall reference 16.

The gripper head 16 comprises a housing 17 having  
30 mounted therein a bell-shaped actuator member 18 constrained to rotate with the housing 17 by means of pegs 19 fixed to the housing 17 and passing through the actuator member 18. The actuator member 18 is mounted to move axially on the pegs 19 and is connected by a hollow  
35 actuator rod 20 to an electromagnetic actuator 21 carried by the slider 6.

Three jaws 22 are mounted inside the actuator member 18 and are moved away from one another by springs shown diagrammatically at 23 and disposed in recesses formed in the facing walls of two adjacent jaws.

5       The inside surface of the actuator member 18 and the outside surfaces of the jaws 22 are frustoconical and include sloping ramps formed by the bottoms of inclined grooves respectively referenced 24 for the actuator member 18, and 25 for the jaws 22, with coupling balls 26  
10       disposed therein so as to constrain the jaws 22 to rotate with the actuator member 18, while allowing the actuator member 18 to move axially relative to the jaws 22. The jaws 22 are retained in an axial direction by the bottom ends of the pegs 19 which extend facing the top edges of  
15       the jaws 22. For this purpose, the gripper head preferably has three pegs 19 disposed in the same angular positions as the grooves 24.

      In the preferred embodiment as shown, the tightener apparatus further comprises a presence detector rod 27  
20       which extends inside the hollow actuator rod 20 and projects above the actuator 21 in register with a proximity detector 48 carried by the slider 6.

      The sheath 10 is slidably received between high and low positions of the spindle 9 in a guide ring 28 mounted  
25       in an orifice 29 of the bottom turntable 3 of the platform 1 with lateral clearance that is the result of a difference between the outside diameter of the guide ring 28 and the diameter of the orifice 29. The guide ring 28 can thus move laterally in the orifice 29 between two  
30       extreme positions, namely: a tightening position (shown in Figure 3); and an end-of-tightening position, as explained below.

      The tightener apparatus includes resilient return means given overall reference 30 for returning the guide  
35       ring 28 into the tightening position (see Figures 3 and 4 in particular).

The resilient return means 30 comprise an arm 31 having a first end 32 hinged to the bottom turntable 3 to pivot about a vertical axis, and a second end 33 to which there is hinged a first end 34 of a lever 35. The lever 35 possesses a second end 36 coupled to a first end 37 of a rod 38 passing through the arm 32 and possessing a second end 39 which is free and has a shoulder (in this case the shoulder is formed by a washer associated with a nut engaged on the end 39). A spring 40 extends around the rod 38 to bear firstly against the arm 31 opposite from the guide ring 28, and secondly against the shoulder at the second end 39 of the rod 38. The lever 35 has a face facing towards the arm 31 which bears against an abutment 41 secured to the bottom turntable 3 so that the spring 40 tends to press an intermediate portion 42 of the arm 31 against the guide ring 28. The abutment 41 is constituted by an eccentric mounted to turn relative to the bottom turntable 3 in order to adjust the angle between the lever 35 and the arm 31 so as to compress the spring 40 to a greater or lesser extent. The abutment 41 thus enables a prestress force to be exerted on the spring 40 and enables it to be adjusted.

A position detector 49 is secured to the bottom turntable 3 facing the second end 33 of the arm 31 to detect the position of said end of the arm 31. The position detector 49 is of the inductive type. The position detector 49 is connected to a switch 50 connected to the actuator 21 to cause the jaws 22 to open when the second end 33 comes into a position corresponding to the end-of-tightening position of the guide ring 28.

The tightener apparatus includes additional guide means arranged to provide accurate guidance of the sliding of the spindle 9 at the beginning of tightening, and to allow the spindle to move laterally at the end of tightening.



The additional guide means comprise a column given overall reference 43 which extends from the top turntable 4 towards the bottom turntable 3. The column 43 possesses a first or top segment 44 connected via a tapering portion 45 to a second or bottom segment 46. The diameter of the top segment is greater than the diameter of the bottom segment 46. The additional guide means include a ring 47 secured to the slider 6 and mounted to slide along the column 43. The inside diameter of the ring 47 is substantially equal to the diameter of the top segment 44.

In operation, the platform 1 rotates about the central column 2 so that the shaft 11 is rotated by the gearwheel 13 meshing with the toothed wheel 14. At the beginning of a cycle, the spindle 9 is in its high position (see Figures 1 and 2). The jaws 22 are spaced apart from one another under the effect of the springs 23, and the radial force exerted by the jaws 22 on the balls 26 pushes back the actuator member 18 of the gripper head 16. The bottom end of the screw cap presence detector rod 27 extends between the jaws 22.

When a screw cap 100 is inserted between the jaws 22, the screw cap presence detector rod 27 is pushed upwards and the proximity detector 48 triggers power feed to the actuator 21. When the actuator 21 is powered it causes the actuator member 18 to move downwards, thereby entraining a radial movement in which the jaws 22 are urged towards one another (see Figures 1 and 2).

The spindle 9 and the gripper head 16 associated therewith are then lowered to engage the screw cap 100 on the neck of the receptacle to be closed, and to begin tightening the screw cap (the vertical sliding movement of the spindle 9 is the result of the platform 1 turning which causes the wheel 7 to travel along the edge of the drum cam 8 which determines the vertical position of the slider 6 and of the spindle 9).

Over a tightening portion (or more precisely over the distance needed for the tamperproofing ring of the screw cap 100 to be forced over a collar on the neck of the receptacle), the spindle 9 is guided laterally by the ring 47 sliding along the top segment 44 of the column 43 and by the slider 6 sliding along the column 5. The ring 47 and the top segment 44 of the column 43 cause the spindle 9 to be guided accurately so that they prevent any lateral movement of the spindle 9 or of the guide ring 28 which is held fast in the tightening position.

The toothed wheel 14 which causes the gearwheel 13 to rotate exerts an off-center force thereon (on which the torque delivered to the spindle 9 depends). The spindle 9, and more precisely the sheath 10, react to said off-center force by applying a force on the guide ring 28 which tends to push the guide ring 28 towards the end-of-tightening position. So long as the ring 47 is on the top segment 44, the ring 47 and the top segment 44 of the column 43 oppose any lateral movement.

Once this portion of tightening has terminated, the ring 47 reaches the bottom segment 46 of the column 43. Because of the difference between the inside diameter of the ring 47 and the diameter of the bottom segment 46, the spindle 9 is free to move laterally so the guide ring 28 is maintained in the tightening position only by the spring 40.

So long as the reaction force applied on the guide ring 28 by the spindle 9 is less than the resilient return force exerted by the spring 40, the spring 40 holds the guide ring 28 and the spindle 9 in the tightening position. Tightening continues with the torque opposing tightening of the screw cap 100 increasing as does the force applied on the guide ring 28 in reaction to the off-center force exerted by the toothed wheel 14. When this reaction force exceeds the resilient return force of the spring 40, the slider 6 pivots about the column 5 and the guide ring 28 is moved

into the end-of-tightening position, causing the arm 31 to pivot so that the second end 33 thereof is moved away from the position detector 49, thereby causing the switch 50 to switch off power feed to the electromagnetic actuator 21. This causes the jaws 22 to open and tightening to cease. The spring 40, the arm 31, the lever 35, the position detector 49, and the guide ring 28 thus form means for detecting the force applied on the sheath 10 (the stationary portion of the spindle 9) in reaction to the off-center drive force. The spring 40 must be prestressed so as to exert a resilient return force on the guide ring 28 that is equal to the reaction force which is exerted on the guide ring 28 by the spindle 9 when the tightening torque desired for the end of tightening is reached. By adjusting the prestress force of the spring 40 it is possible to adjust the reaction force threshold above which tightening is interrupted, thus making it possible to adjust tightening torque.

With continued rotation of the platform 1, the spindle 9 is returned to the high position and the tightener apparatus is ready to begin a new tightening cycle.

In the description below, elements that are identical or analogous to elements described with reference to the first embodiment are given the same references.

With reference to Figure 5, in the second embodiment of the tightener apparatus, the spindle 9 is slidably received in a guide ring 60 held in a hole 61 in the bottom turntable 3.

A conventional strain gauge 62 is interposed between the wall of the hole 61 and the outside surface of the guide ring 60.

The strain gauge 62, which detects the bearing reaction of the spindle 9 on the guide ring 60, thus forms means for detecting the force applied on a portion

of the spindle 9 which is prevented from rotating (i.e. the sheath 10) in reaction to the drive force.

The strain gauge 62 is connected in conventional manner to a unit for processing the information supplied  
5 by the strain gauge 62 in order to calculate therefrom the tightening torque that is being exerted on the screw cap and in order to cause tightening to stop when the desired tightening torque has been reached. The processor unit may be connected to the control desk of  
10 the capping installation in such a manner as to inform an operator about the value of the tightening torque.

Naturally, the invention is not limited to the embodiments described and variant embodiments can be applied thereto without going beyond the ambit of the  
15 invention as defined by the claims.

In particular, the spindle may be made in two portions that are coupled together, e.g. by means of a resilient coupling comprising any suitable means such as a torsion spring or even an elastomer sleeve disposed  
20 between the drive shaft and the rotary spindle, or by an electromagnetic coupling device that is controllable to lock together or to release the two portions of the spindle. In which case, at the end of tightening, it is preferable for the means that cause tightening to stop,  
25 to begin by separating the two portions of the spindle, and then to open the jaws.

Instead of being received in an orifice 29 of circular shape, the guide ring 28 may be received in an elongate slot, e.g. a kidney-shaped slot centered on the  
30 axis of the column 5 so that the direction in which clearance is provided is substantially parallel to the direction in which the off-center drive is applied.

It is also possible to implement the invention using gripper heads in which each gripper head carries its own  
35 actuator. Nevertheless, in this respect, it should be observed that the apparatus constituting the preferred embodiment of the invention is capable of operating

without making use of any friction contact, which constitutes a significant advantage in terms of the reliability with which the apparatus operates.

Furthermore, rotation of the gripper head 16 can be  
5 started and stopped by means of a clutch interposed  
anywhere along the drive chain for setting the drive  
shaft 11 in rotation.

The invention can be used in equipment having only  
one tightener apparatus.

10 The tightener apparatus may be of a structure  
different from that described above, for example the  
spindle may be mounted so as to be capable only of  
rotating relative to the turntable.